

Description

Background of the invention

This invention relates to the field of compatible AM stereo signals and, more particularly, to the provision of an improved means of restoring stereo program signals.

In one known receiver for decoding stereo signals from a received signal of the form

$$(1+L+R) \cos(\omega_c t + \phi)$$

where ϕ is

$$\arctan((L-R)/(1+L+R)),$$

approximate stereo signals of the form $R \cos \phi$ and $L \cos \phi$ were obtained from two synchronous detectors. This receiver was disclosed in U.S. Patent No. 4,218,586. A $\cos \phi$ correction signal was determined by means of limiter and phase locked loop, and the two approximate signals were divided by the $\cos \phi$ correction signal to retrieve the stereo information signals. Another receiver, disclosed in U.S. Patent No. 4,192,968 derived the sum signal $(1+L+R)$ by means of an envelope detector, and the difference signal was obtained from a signal $(L-R) \cos \phi$ by division by a signal proportional to $\cos \phi$.

A receiver in accordance with the prior art portion of claim 1 is known from another U.S. Patent No. 4,172,966. A receiver is shown which uses envelope detection for obtaining the monophonic or $1+L+R$ signal and uses tangential correction in obtaining the difference or $L-R$ signal. The phase information is provided by a phase detector and amplified in a non-linear or tangential amplifier.

The tangential output is multiplied by the monophonic signal and the result is the difference signal which is then matrixed with the monophonic signal to obtain the stereo signals L and R .

Summary of the invention

It is an object of the present invention to provide an improved means of decoding a compatible AM stereophonic signal to obtain the original information signals.

This object is obtained in a circuit of the present invention in which the matrixing means is coupled to receive a signal $(L-R)$ fed from the multiplier means (30) and in which amplifier means is provided for comparing a true amplitude modulation signal fed from the detection means (22) with an approximate amplitude modulation signal fed from the multiplier means (28) and for providing an output cosine signal proportional to the inverse of $\cos \phi$, and in which means is provided for coupling the correction signal back to the multiplier means (28, 30) to correct the output of the multiplier means.

Brief description of drawings

Fig. 1 is a block diagram of a receiver in accordance with the invention.

Fig. 2A is a block diagram of a second embodiment of the invention.

Fig. 2B is a schematic diagram of one portion of Fig. 2A.

Fig. 3 is a schematic diagram of a second embodiment of one portion of the block diagrams.

Detailed description of the preferred embodiment

In Fig. 1, a signal of the form

$$(1+L+R) \cos(\omega_c t + \phi)$$

is received and detected in an RF stage 10, processed in an IF stage 12, and coupled to multipliers 14, 16. A local oscillator 18 output is coupled directly to multiplier 14, and through a 90° phase shifter 20, to multiplier 16. The output signal from multiplier 14 is then $(1+L+R) \cos \phi$. The output signal from the multiplier 16 is the quadrature signal $(L-R) \cos \phi$.

The output of the IF stage 12 is also coupled to an envelope detector 22. The output of the detector is then $1+L+R$, the compatible monophonic signal. This sum signal is normally coupled to a matrix 24, and is also coupled to one input of a high gain operational amplifier 26. The inverting input of the amplifier is coupled from the output of a multiplier 28, and the output of the amplifier is coupled back to an input of the multiplier 28. The second input of multiplier 28 comes from the multiplier 14. The combination of the multiplier 28, amplifier 26 and the feedback loop forces the output signal of multiplier 28 to become $1+L+R$, which could, of course, be coupled to the matrix 24 in place of the output signal from the envelope detector 22. The amplifier 26 may also comprise a comparator/amplifier rather than an operational amplifier, since high gain is not required.

The output signal of the amplifier 26, which approaches $1/\cos \phi$ very closely, depending on the gain of the amplifier, is also coupled to an input of a fourth multiplier 30. The other input of the multiplier 30 is the $(L-R) \cos \phi$ output signal from the multiplier 16, thus the multiplier 30 output becomes $L-R$. This difference signal is coupled to the matrix 24 which outputs the original left (L) and right (R) information signals. The four multipliers 14, 16, 28, 30 may be implemented by one four-quadrant multiplier integrated circuit such as the Motorola MC1595 chip.

A slightly different embodiment of the invention is shown in Figs. 2A and 2B, in which the antenna and RF stage 10 have been omitted for simplicity. The IF stage 12 has been represented by a transformer (Fig. 2B) and is coupled to the envelope detector 22, and the envelope

detector output is coupled to the amplifier 26 and the matrix 24 as in Fig. 1. Two resistors 31, 32 are coupled to the transformer secondary and two diodes 33, 34 are coupled across the secondary to function as multiplier 36, and a current proportional to the amplifier 26 output is coupled to the junction point of the two diodes. The diode 36 output terminals are coupled to two multipliers 38, 40 as are the local oscillator 18 and 90° phase shifter 20. Thus the multiplication process (times $1/\cos \phi$) takes place in the multiplier 36 rather than in multipliers 28, 30 of Fig. 1. The respective output signals of multipliers 38, 40 are then $(1+L+R)$ and $(L-R)$. The function of amplifier 26 is the same as in Fig. 1; i.e., to force the output of multiplier 38 to approach $1+L+R$ by means of the feedback to multiplier 36. As before, the matrix receives $1+L+R$ and $L-R$ and provides at the output terminals the original information signals L and R .

In Fig. 3 is shown a second embodiment of the oscillator/phase shifter combination, wherein the oscillator output is coupled to two divide-by-two dividers 42, 44. The dividers divide in opposite phases and thus their outputs are in quadrature.

Claims

1. A receiver for receiving AM stereophonic signals of the form

$$(1+L+R) \cos (w_c t + \phi)$$

where L and R are information signals, $w_c t$ is a carrier frequency and ϕ is

$$\arctan ((L-R)/(1+L+R)),$$

and comprising:

means (10, 12) for selectively receiving said stereophonic signals;

means (22) coupled to the selective receiving means for detecting the amplitude modulation on the received signal to provide a signal equal to $(1+L+R)$;

means (18, 20) for providing two carrier signals in quadrature;

multiplier means (14, 16, 28, 30) coupled to the selective receiving means and to the carrier signal means;

matrixing means (24) coupled to receive the signal $(1+L+R)$ and to provide output signals substantially equal to L and R ; and characterized in that the matrixing means is coupled to receive a signal $(L-R)$ fed from the multiplier means (30) and in that amplifier means (26) is provided for comparing a true amplitude modulation signal fed from the detection means (22) with an approximate amplitude modulation signal fed from the multiplier means (28) and for providing an output correction signal proportional to the

inverse of $\cos \phi$, and means for coupling the correction signal back to the multiplier means (28, 30) to correct the output of the multiplier means.

2. A receiver in accordance with claim 1 wherein the multiplier means (14, 16, 28, 30) comprises a first multiplier (14) coupled to multiply a signal from the selective receiving means (10, 12) and a first signal from the carrier signal providing means (18, 20), a second multiplier (16) coupled to multiply the signal from the selective receiving means and a second signal from the carrier signal providing means, a third multiplier (28) coupled to multiply the output signal of the first multiplier (14) and the output signal of the amplifier means (26), a fourth multiplier (30) coupled to multiply the output signal from the second multiplier (16) and the output signal from the amplifier means (26).

3. A receiver in accordance with claim 1 wherein the multiplier means (36, 38, 40) comprises a first multiplier (36) coupled to multiply a signal from the selective receiving means (10, 12) and a signal from the amplifier means (26), a second multiplier (38) coupled to multiply a signal from the first multiplier (36) and a signal from the carrier providing means (18, 20), and a third multiplier (40) coupled to multiply the signal from the first multiplier and a second signal from the carrier providing means.

4. A receiver in accordance with claim 1 wherein the carrier providing means comprises an oscillator means (18) and a 90° phase shifting means (20).

5. A receiver in accordance with claim 1 wherein the carrier providing means includes an oscillator (18) and two divider means (42, 44).

6. A receiver in accordance with claim 1 wherein the selective receiving means comprises an RF stage (10) and an IF stage (12).

Patentansprüche

1. Empfänger zum Empfang von stereophonen AM Signalen in der Form von

$$(1+L+R) \cos (w_c t + \phi),$$

worin L und R Informationssignale sind, $w_c t$ eine Trägerfrequenz und ϕ gleich ist

$$\arctan ((L-R)/(1+L+R)),$$

mit

einer Einrichtung (10, 12) für den selektiven Empfang der stereophonen Signale;

einer an die selektive empfangende Einrichtung gekoppelte Einrichtung (22) zum Erfassen der Amplitudenmodulation bei dem empfangenen Signal, um ein Signal zu erzeugen, welches gleich ist $(1+L+R)$;

einer Einrichtung (18, 20) zum Erzeugen zweier um 90° phasenverschobener Trägersignale;

detector output is coupled to the amplifier 26 and the matrix 24 as in Fig. 1. Two resistors 31, 32 are coupled to the transformer secondary and two diodes 33, 34 are coupled across the secondary to function as multiplier 36, and a current proportional to the amplifier 26 output is coupled to the junction point of the two diodes. The diode 36 output terminals are coupled to two multipliers 38, 40 as are the local oscillator 18 and 90° phase shifter 20. Thus the multiplication process (times $1/\cos \phi$) takes place in the multiplier 36 rather than in multipliers 28, 30 of Fig. 1. The respective output signals of multipliers 38, 40 are then $(1+L+R)$ and $(L-R)$. The function of amplifier 26 is the same as in Fig. 1; i.e., to force the output of multiplier 38 to approach $1+L+R$ by means of the feedback to multiplier 36. As before, the matrix receives $1+L+R$ and $L-R$ and provides at the output terminals the original information signals L and R .

In Fig. 3 is shown a second embodiment of the oscillator/phase shifter combination, wherein the oscillator output is coupled to two divide-by-two dividers 42, 44. The dividers divide in opposite phases and thus their outputs are in quadrature.

Claims

1. A receiver for receiving AM stereophonic signals of the form

$$(1+L+R) \cos (w_c t + \phi)$$

where L and R are information signals, $w_c t$ is a carrier frequency and ϕ is

$$\arctan ((L-R)/(1+L+R)),$$

and comprising:

means (10, 12) for selectively receiving said stereophonic signals;
means (22) coupled to the selective receiving means for detecting the amplitude modulation on the received signal to provide a signal equal to $(1+L+R)$;
means (18, 20) for providing two carrier signals in quadrature;
multiplier means (14, 16, 28, 30) coupled to the selective receiving means and to the carrier signal means;
matrixing means (24) coupled to receive the signal $(1+L+R)$ and to provide output signals substantially equal to L and R ; and characterized in that the matrixing means is coupled to receive a signal $(L-R)$ fed from the multiplier means (30) and in that amplifier means (26) is provided for comparing a true amplitude modulation signal fed from the detection means (22) with an approximate amplitude modulation signal fed from the multiplier means (28) and for providing an output correction signal proportional to the

inverse of $\cos \phi$, and means for coupling the correction signal back to the multiplier means (28, 30) to correct the output of the multiplier means.

2. A receiver in accordance with claim 1 wherein the multiplier means (14, 16, 28, 30) comprises a first multiplier (14) coupled to multiply a signal from the selective receiving means (10, 12) and a first signal from the carrier signal providing means (18, 20), a second multiplier (16) coupled to multiply the signal from the selective receiving means and a second signal from the carrier signal providing means, a third multiplier (28) coupled to multiply the output signal of the first multiplier (14) and the output signal of the amplifier means (26), a fourth multiplier (30) coupled to multiply the output signal from the second multiplier (16) and the output signal from the amplifier means (26).

3. A receiver in accordance with claim 1 wherein the multiplier means (36, 38, 40) comprises a first multiplier (36) coupled to multiply a signal from the selective receiving means (10, 12) and a signal from the carrier providing means (18, 20), a second multiplier (38) coupled to multiply a signal from the first multiplier (36) and a signal from the carrier providing means (18, 20), and a third multiplier (40) coupled to multiply the signal from the first multiplier and a second signal from the carrier providing means.

4. A receiver in accordance with claim 1 wherein the carrier providing means comprises an oscillator means (18) and a 90° phase shifting means (20).

5. A receiver in accordance with claim 1 wherein the carrier providing means includes an oscillator (18) and two divider means (42, 44).

6. A receiver in accordance with claim 1 wherein the selective receiving means comprises an RF stage (10) and an IF stage (12).

Patentansprüche

1. Empfänger zum Empfang von stereophonen AM Signalen in der Form von

$$(1+L+R) \cos (w_c t + \phi),$$

worin L und R Informationssignale sind, $w_c t$ eine Trägerfrequenz und ϕ gleich ist

$$\arctan ((L-R)/(1+L+R)),$$

mit

einer Einrichtung (10, 12) für den selektiven Empfang der stereophonen Signale;
einer an die selektive empfangende Einrichtung gekoppelte Einrichtung (22) zum Erfassen der Amplitudenmodulation bei dem empfangenen Signal, um ein Signal zu erzeugen, welches gleich ist $(1+L+R)$;
einer Einrichtung (18, 20) zum Erzeugen zweier um 90° phasenverschobener Trägersignale;



einer Multipliziereinrichtung (14, 16, 28, 30), die an die selektiv empfangende Einrichtung und an die Einrichtung zum Erzeugen der Trägersignale gekoppelt ist;

einer Matrixschaltung (24), welche so geschaltet ist, daß sie das Signal $(1+L+R)$ empfängt und welche Ausgangssignale erzeugt, die im wesentlichen gleich sind mit L und R dadurch gekennzeichnet, daß die Matrixschaltung so geschaltet ist, daß sie ein Signal $(L-R)$ empfängt, welches von der Multipliziereinrichtung (30) zugeführt wird, und daß eine Verstärkereinrichtung (26) vorgesehen ist, um ein tatsächliches von der Detektoreinrichtung (22) zugeführtes Amplitudenmodulationssignal mit einem angenäherten Amplitudenmodulationssignal zu vergleichen, welches von der Multipliziereinrichtung (28) geliefert wird, und um ein Korrektur Ausgangssignal zu erzeugen, welches proportional zur inversen Größe von $\cos \phi$ ist und daß eine Kopplungseinrichtung vorgesehen ist, um das Korrektursignal zur Multipliziereinrichtung (28, 30) zurückzukoppeln, um die Ausgangsgröße der Multipliziereinrichtung zu korrigieren.

2. Empfänger nach Anspruch 1, bei dem die Multipliziereinrichtung (14, 16, 28, 30) einen ersten Multiplizierer (14) aufweist, der zum Multiplizieren eines Signals von der selektiven Empfangereinrichtung (10, 12) mit einem ersten Signal von der Einrichtung (18, 20) zum Vorsehen der Trägersignale geschaltet ist, einen zweiten Multiplizierer (16), der zum Multiplizieren des Signals von der selektiven Empfangereinrichtung mit einem zweiten Signal von der Einrichtung zum Vorsehen der Trägersignale geschaltet ist, einen dritten Multiplizierer (28), der zum Multiplizieren des Ausgangssignals des ersten Multiplizierers (14) mit dem Ausgangssignal der Verstärkereinrichtung (26) geschaltet ist, und einen vierten Multiplizierer (30), der zum Multiplizieren des Ausgangssignals des zweiten Multiplizierers (16) mit dem Ausgangssignal der Verstärkereinrichtung (26) geschaltet ist.

3. Empfänger nach Anspruch 1, bei dem die Multipliziereinrichtung (36, 38, 40) einen ersten Multiplizierer (36) aufweist, der zum Multiplizieren eines Signals von der selektiven Empfangereinrichtung (10, 12) mit einem Signal von der Verstärkereinrichtung (26) geschaltet ist, einen zweiten Multiplizierer (38), der zum Multiplizieren eines Signals von dem ersten Multiplizierer (36) mit einem Signal von der Einrichtung (18, 20) zum Vorsehen der Trägersignale geschaltet ist, und einen dritten Multiplizierer (40), der zum Multiplizieren des Signals vom ersten Multiplizierer mit einem zweiten Signal von der Einrichtung zum Vorsehen der Trägersignale geschaltet ist.

4. Empfänger nach Anspruch 1, bei dem die Einrichtung zum Vorsehen der Trägersignale

einen Oszillator (18) und einen 90°-Phasenschieber (20) umfaßt.

5. Empfänger nach Anspruch 1, bei dem die Einrichtung zum Vorsehen der Trägersignale einen Oszillator (18) und zwei Teilervorrichtungen (42, 43) umfaßt.

6. Anspruch nach Anspruch 1, bei dem die selektive Empfangseinrichtung eine HF-Stufe (10) und eine ZF-Stufe (12) umfaßt.

Revendications

1. Récepteur conçu pour recevoir des signaux stéréophoniques A.M. de la forme

$$(1+G+D) \cos (\omega_c t + \phi),$$

où G et D sont des signaux d'information, $\omega_c t$ est une fréquence porteuse et ϕ correspond

$$\text{à } \operatorname{tg} ((G-D)/(1+G+D)),$$

et comprenant:

un dispositif (10, 12) pour recevoir sélectivement les signaux stéréophoniques;
un dispositif (22) couplé au dispositif de réception sélective pour détecter la modulation d'amplitude sur le signal reçu afin de fournir un signal égal à $(1+G+D)$;
un dispositif (18, 20) pour produire deux signaux porteurs en quadrature;
un dispositif multiplicateur (14, 16, 28, 30) couplé au dispositif de réception sélective et au dispositif produisant les signaux porteurs; et
un dispositif de matricage (24) couplé pour recevoir le signal $(1+G+D)$ et pour délivrer des signaux de sortie sensiblement égaux à G et D, caractérisé en ce que le dispositif de matricage est couplé pour recevoir un signal $(G-D)$ fourni par le dispositif multiplicateur (30) et en ce qu'un dispositif amplificateur (26) est prévu pour comparer un signal de modulation d'amplitude exact fourni par le dispositif de détection (22) avec un signal de modulation d'amplitude approximatif fourni par le dispositif multiplicateur (28), ainsi que pour délivrer un signal de correction de sortie proportionnel à l'inverse de $\cos \phi$, de même qu'un dispositif pour appliquer le signal de correction en réaction au dispositif multiplicateur (28, 30) pour corriger le signal de sortie du dispositif multiplicateur.

2. Récepteur selon la revendication 1, où le dispositif multiplicateur (14, 16, 28, 30) comprend un premier multiplicateur (14) couplé pour multiplier un signal du dispositif de réception sélective (10, 12) et un premier signal du dispositif producteur de signaux porteurs (18, 20), un second multiplicateur (16) couplé pour multiplier le signal du dispositif de réception sélective et un second signal du dispositif producteur de signaux porteurs, un troisième



multiplicateur (28) couplé pour multiplier le signal de sortie du premier multiplicateur (14) et le signal de sortie du dispositif amplificateur (26), ainsi qu'un quatrième multiplicateur (30) couplé pour multiplier le signal de sortie du second multiplicateur (16) et le signal de sortie du dispositif amplificateur (26).

3. Récepteur selon la revendication 1, où le dispositif multiplicateur (36, 38, 40) comprend un premier multiplicateur (36) couplé pour multiplier un signal du dispositif de réception sélective (10, 12) et un signal du dispositif amplificateur (26), un second multiplicateur (28) couplé pour multiplier un signal du premier multiplicateur (36) et un signal du dispositif producteur de signaux porteurs (18, 20), ainsi

qu'un troisième multiplicateur (40) couplé pour multiplier le signal du premier multiplicateur et un second signal du dispositif producteur de signaux porteurs.

5 4. Récepteur selon la revendication 1, où le dispositif producteur de signaux porteurs comprend un dispositif oscillateur (18) et un dispositif de déphasage de 90° (20).

10 5. Récepteur selon la revendication 1, où le dispositif producteur de signaux porteurs comporte un oscillateur (18) et deux dispositifs diviseurs (42, 44).

15 6. Récepteur selon la revendication 1, où le dispositif de réception sélective comprend un étage HF (10) et un étage FI (12).

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